

Mosquitoes (Insecta: Diptera: Culicidae) of the Florida Keys, Florida, United States of America

Lawrence J. Hribar^{1*}, Andrea L. Leal², David J. DeMay¹ and Adriane N. Tambasco³

¹ Florida Keys Mosquito Control District, 503 107th Street, Marathon, FL 33050, USA.

² Florida Keys Mosquito Control District, 5224 College Road, Key West, FL 33040, USA.

³ Florida Keys Mosquito Control District, 100701 Overseas Highway, Key Largo, FL 33037, USA.

* Corresponding author. Email: lhribar@keysmosquito.org

ABSTRACT: A list of the Culicidae collected in the Florida Keys is presented. Mosquito records were obtained from the scientific literature and from collections made by mosquito control personnel. Forty-eight species or species groups are known from the Florida Keys.

INTRODUCTION

The Florida Keys comprise an archipelago that surrounds the southern tip of the state of Florida (Figure 1). Although the word “key” is used for many small islands near the Florida coast, the Florida Keys proper are those islands extending from Soldier Key in the northeast to Key West in the southwest. There is a natural division in the island chain, the Upper Keys, those from Soldier Key to Bahia Honda Key; and the Lower Keys, those from Big Pine Key to Key West. The division is due to the underlying rock: the Upper Keys are composed of Key Largo Limestone and the Lower Keys of Miami oölitic limestone (Hoffmeister and Multer 1968). The Upper and Lower Keys differ in terms of vegetation, rainfall, and permeability of bedrock (Stern and Brizicky 1957; Snyder *et al.* 1990; Corbett *et al.* 1999). The highest point in the Florida Keys is about 5.5 meters above sea level; most of the islands lie below 2 meters above sea level (Ross *et al.* 1992).

Mosquitoes (Insecta: Diptera: Culicidae) are perhaps the most important haematophagous insects impacting human and animal health. They serve as vectors of numerous disease organisms, including bacteria, protozoa, and helminths. Mosquitoes also serve as food items for other animals.

MATERIALS AND METHODS

Mosquito records were located via review of relevant literature and from unpublished collection records of the Florida Keys Mosquito Control District. Collections of mosquitoes were made by Florida Keys Mosquito Control District staff from May 1998 to August 2010. Larvae and pupae were collected via use of dippers, pipettes, or aquarium nets. Adults were collected in various kinds of traps, such as CDC light traps, ABC light traps (unbaited or baited with carbon dioxide), BG Sentinel[®] traps, and Mosquito Magnet[®] traps. All specimens were identified by District staff, except for a few that were sent to a taxonomist for identification or verification. Voucher specimens are

deposited in the Florida State Collection of Arthropods, the Yale University Peabody Museum of Natural History, and the collection maintained by the Florida Keys Mosquito Control District. Collections on Federal and State lands were made after issuance of permits by the United States Fish and Wildlife Service or the Florida Department of Environmental Protection.

RESULTS AND DISCUSSION

Forty-eight species or species groups of mosquitoes have been reported from the Florida Keys (Table 1). One difficulty in tracing the development of the faunal list of mosquitoes from the Florida Keys is that there were numerous changes in nomenclature during the early Twentieth Century and there is often an abundance of synonyms to unravel. This review of the mosquito fauna of the Florida Keys will present a historical treatment of the development of knowledge of the mosquito fauna of the Florida Keys. Generic and subgeneric abbreviations follow Reinert (1975).

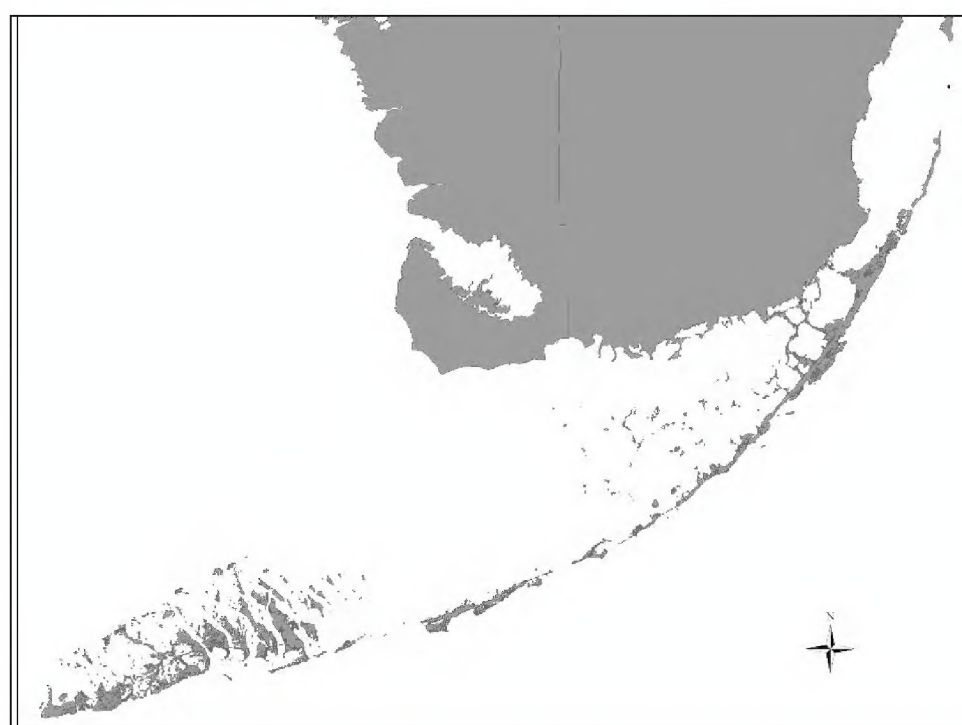


FIGURE 1. The southern portion of the Florida peninsula and the Florida Keys.

TABLE 1. The southern portion of the Florida peninsula and the Florida Keys.

TAXON	LOCALITY
ANOPHELINAE	
<i>Anopheles (Anopheles) atropos</i> Dyar and Knab	Annette Key, Bahia Honda Key, Big Coppitt Key, Big Pine Key, Big Torch Key, Boca Chica Key, Cross Key, Cudjoe Key, Elliott Key, Geiger Key, Grassy Key, Howe Key, Indian Key, Key Largo, Key West, Lignumvitae Key, Little Pine Key, Little Knockemdown Key, Long Key, Long Point Key, Lower Matecumbe Key, Middle Torch Key, No Name Key, Plantation Key, Pumpkin Keys, Raccoon Key, Ramrod Key, Stock Island, Sugarloaf Key, Summerland Key, Sunrise Cay, “Torch Key”, Upper Matecumbe Key, Vaca Key, Water Key, Water Keys, Windley Key
<i>An. (Ano.) bradleyi</i> King	Key Largo, Lower Matecumbe Key
<i>An. (Ano.) crucians</i> Wiedemann	Big Pine Key, Indian Key, Lower Matecumbe Key, Ramrod Key
<i>An. (Ano.) crucians</i> complex (females)	Annette Key, Bahia Honda Key, Big Coppitt Key, Big Pine Key, Big Torch Key, Boca Chica Key, Cross Key, Cudjoe Key, Geiger Key, Grassy Key, Key Largo, Key West, Lignumvitae Key, Little Knockemdown Key, Little Pine Key, Long Key, Middle Torch Key, No Name Key, Plantation Key, Raccoon Key, Rodriguez Key, Stock Island, Sugarloaf Key, Summerland Key, Sunrise Cay, Upper Matecumbe, Vaca Key, Water Keys, Windley Key
<i>An. (Ano.) grabhamii</i> Theobald	Big Pine Key, Big Torch Key, Key West, Middle Torch Key, No Name Key, Sugarloaf Key
<i>An. (Ano.) quadrimaculatus</i> complex	Big Pine Key, Big Torch Key, Key Largo, Key West, Plantation Key, Sugarloaf Key
<i>An. (Ano.) walkeri</i> Theobald	Key Largo
<i>An. (Nyssorhynchus) albimanus</i> Wiedemann	Big Pine Key, Crawl Key, Grassy Key, Key Largo, Key West, Long Key, Lower Matecumbe Key, No Name Key, Stock Island, Upper Matecumbe Key, Vaca Key
CULICINAE	
AEDINI	
<i>Aedes (Ochlereotatus) atlanticus</i> Dyar and Knab	Annette Key, Big Pine Key, Big Torch Key, Cudjoe Key, Grassy Key, Key Largo, Lignumvitae Key, Little Knockemdown Key, Long Key, No Name Key, Plantation Key, Stock Island, Windley Key
<i>Ae. (Och.) condolezens</i> Dyar and Knab	Annette Key, Big Coppitt Key, Big Pine Key, Big Torch Key, Boca Chica Key, Boot Key, Cross Key, Cudjoe Key, Geiger Key, Grassy Key, Howe Key, Key Largo, Key West, Lignumvitae Key, Little Knockemdown Key, Little Pine Key, Long Key, Middle Torch Key, No Name Key, Plantation Key, Raccoon Key, Ramrod Key, Rodriguez Key, Stock Island, Sugarloaf Key, Summerland Key, Sunrise Cay, Upper Matecumbe Key, Vaca Key, Water Keys, Windley Key
<i>Ae. (Och.) infirmatus</i> Dyar and Knab	Big Pine Key, Big Torch Key, Cudjoe Key, Cross Key, Geiger Key, Grassy Key, Key Largo, Key West, Little Knockemdown Key, Long Key, No Name Key, Plantation Key, Stock Island, Sugarloaf Key, Upper Matecumbe Key, Vaca Key, Windley Key
<i>Ae. (Och.) mitchellae</i> (Dyar)	Big Torch Key
<i>Ae. (Och.) scapularis</i> (Rondani)	Vaca Key
<i>Ae. (Och.) sollicitans</i> (Walker)	Annette Key, Big Pine Key, Big Torch Key, Boca Chica Key, Cross Key, Cudjoe Key, Grassy Key, Horseshoe Key, Howe Key, Johnson Key, Key Largo, Key West, Lignumvitae Key, Little Knockemdown Key, Little Pine Key, Long Key, Long Point Key, Middle Torch Key, No Name Key, Plantation Key, Raccoon Key, Ramrod Key, Stock Island, Sugarloaf Key, Summerland Key, Vaca Key, Water Key, Water Keys
<i>Ae. (Och.) taeniorhynchus</i> (Wiedemann)	Annette Key, Bahia Honda Key, Bamboo Key, Big Coppitt Key, Big Munson Key, Big Pine Key, Big Torch Key, Boca Chica Key, Boot Key, “Crawl Keys”, Cross Key, Cudjoe Key, Duck Key, Fat Deer Key, Geiger Key, Grassy Key, Horseshoe Key, Howe Key, Indian Key, Johnson Key, Key Largo, Key West, Knights Key, Lignumvitae Key, Little Knockemdown Key, Little Pine Key, Loggerhead Key, Long Key, Long Point Key, Lower Matecumbe Key, Middle Torch Key, No Name Key, Plantation Key, Raccoon Key, Ramrod Key, Stock Island, Sugarloaf Key, Summerland Key, Toptree Hammock Key, “Torch Key”, Upper Matecumbe Key, Vaca Key, Water Key, Water Keys, Windley Key
<i>Ae. (Och.) thelcter</i> Dyar	Big Coppitt Key, Boca Chica Key, “Crawl Key No. 1”, Key Largo, Key West, Long Key, Vaca Key

TABLE 1. CONTINUED.

TAXON	LOCALITY
<i>Ae. (Och.) tortilis</i> (Theobald)	Annette Key, Big Coppitt Key, Big Pine Key, Big Torch Key, Boca Chica Key, Boot Key, “Crawl Keys”, Cross Key, Cudjoe Key, Geiger Key, Grassy Key, Key Largo, Key West, Lignumvitae Key, Little Pine Key, Long Key, Lower Matecumbe Key, Middle Torch Key, No Name Key, Plantation Key, Ramrod Key, Stock Island, Sugarloaf Key, Summerland Key, Upper Matecumbe Key, Vaca Key, Water Keys, Windley Key
<i>Ae. (Protomacleaya) triseriatus</i> (Say)	Annette Key, Big Pine Key, Big Torch Key, Boca Chica Key, Boot Key, Cudjoe Key, Cross Key, Indian Key, Key Largo, Lignumvitae Key, Little Knockemdown Key, Little Pine Key, Long Key, Plantation Key, Rodriguez Key, Sugarloaf Key, Summerland Key, Sunrise Cay, Upper Matecumbe Key, Water Keys, Windley Key
<i>Ae. (Stegomyia) aegypti</i> Linnaeus	Annette Key, Bahia Honda Key, Big Coppitt Key, Big Pine Key, Big Torch Key, Crawl Key, Cross Key, Cudjoe Key, Duck Key, Fat Deer Key, Geiger Key, Grassy Key, Key Largo, Key West, Lignumvitae Key, Little Pine Key, Little Torch Key, Long Key, Lower Matecumbe Key, Middle Torch Key, No Name Key, Plantation Key, Ramrod Key, Rodriguez Key, Saddlebunch Keys, Shelter Key, Stock Island, Sugarloaf Key, Summerland Key, Sunrise Cay, Upper Matecumbe Key, Vaca Key, Windley Key
<i>Ae. (Stg.) albopictus</i> (Skuse)	Big Pine Key, Key Largo, Key West, Stock Island, Upper Matecumbe Key
<i>Psorophora (Psorophora) ciliata</i> (F.)	Annette Key, Big Pine Key, Big Torch Key, Cudjoe Key, Grassy Key, Key Largo, Key West, Little Knockemdown Key, Little Pine Key, Middle Torch Key, No Name Key, Raccoon Key, Stock Island, Sugarloaf Key, Summerland Key, Water Key, Water Keys
<i>Ps. (Pso.) howardii</i> Coquillett	Stock Island
<i>Ps. (Grabhamia) columbiae</i> (Dyar and Knab)	Annette Key, Big Pine Key, Big Torch Key, Boca Chica Key, Cudjoe Key, Geiger Key, Grassy Key, Key Largo, Key West, Little Pine Key, Long Key, Middle Torch Key, No Name Key, Ramrod Key, Stock Island, Sugarloaf Key
<i>Ps. (Gra.) pygmaea</i> (Theobald)	Annette Key, Big Coppitt Key, Pig Pine Key, Boca Chica Key, Cudjoe Key, Geiger Key, Key West, Middle Torch Key, Ramrod Key, Sugarloaf Key, Summerland Key
<i>Ps.(Janthinosoma) ferox</i> (Von Humboldt)	Annette Key, Big Pine Key, Big Torch Key, Boca Chica Key, Cudjoe Key, Key Largo. Little Pine Key, Middle Torch Key, Sugarloaf Key
<i>Ps. (Jan.) johnstonii</i> (Grabham)	Annette Key, Big Coppitt Key, Big Pine Key, Big Torch Key, Boca Chica Key, Cudjoe Key, Geiger Key, Key Largo, Key West, Lignumvitae Key, Little Knockemdown Key, Little Pine Key, Long Key, Lower Matecumbe Key, Middle Torch Key, No Name Key, Plantation Key, Raccoon Key, Ramrod Key, Sugarloaf Key, Summerland Key, Vaca Key, Water Keys, Windley Key
CULISETINI	
<i>Culiseta (Climacura) melanura</i> (Coquillett)	No Name Key
<i>Cs. (Culiseta) inornata</i> (Williston)	Big Pine Key, Big Torch Key, Boot Key, Geiger Key, Grassy Key, Key Largo, Little Pine Key, Middle Torch Key, No Name Key, Stock Island, Sugarloaf Key, Water Keys
CULICINI	
<i>Culex (Culex) bahamensis</i> Dyar and Knab	Annette Key, Bahia Honda Key, Big Coppitt Key, Big Pine Key, Big Torch Key, Boca Chica Key, Cudjoe Key, Elliott Key, Fat Deer Key, Geiger Key, Johnson Key, Key Largo, Key West, Knights Key, Lignumvitae Key, Little Knockemdown Key, Little Pine Key, Long Key, Long Point Key, Lower Matecumbe Key, Middle Torch Key, No Name Key, Plantation Key, Pumpkin Keys, Raccoon Key, Ramrod Key, Stock Island, Sugarloaf Key, Summerland Key, Upper Matecumbe Key, Vaca Key, Water Key, Water Keys, Windley Key
<i>Cx. (Cux.) declarator</i> Dyar and Knab	Big Coppitt Key, Big Pine Key, Big Torch Key, Cross Key, Cudjoe Key, Geiger Key, Key Largo, Key West, Little Knockemdown Key, Little Pine Key, Long Key, Middle Torch Key, No Name Key, Ramrod Key, Stock Island, Sugarloaf Key, Summerland Key, Sunrise Cay, Upper Matecumbe Key, Vaca Key
<i>Cx. (Cux.) nigripalpus</i> Theobald	Annette Key, Big Coppitt Key, Big Pine Key, Big Torch Key, Boca Chica Key, Boot Key, Cross Key, Cudjoe Key, Geiger Key, Grassy Key, Key Largo, Key West, Lignumvitae Key, Little Knockemdown Key, Little Pine Key, Long Key, Long Point Key, Middle Torch Key, No Name Key, Plantation Key, Raccoon Key, Ramrod Key, Stock Island, Sugarloaf Key, Summerland Key, Upper Matecumbe Key, Vaca Key, Water Keys, Windley Key

TABLE 1. CONTINUED.

TAXON	LOCALITY
<i>Cx. (Cux.) quinquefasciatus</i> Say	Annette Key, Big Coppitt Key, Big Pine Key, Big Torch Key, Boca Chica Key, Boot Key, Cross Key, Cudjoe Key, Duck Key, Fat Deer Key, Geiger Key, Grassy Key, Key Largo, Key West, Lignumvitae Key, Little Pine Key, Long Key, Lower Matecumbe Key, Middle Torch Key, No Name Key, Plantation Key, Ramrod Key, Stock Island, Sugarloaf Key, Summerland Key, Upper Matecumbe Key, Vaca Key, Windley Key
<i>Cx. (Cux.) salinarius</i> Coquillett	Big Pine Key, Cudjoe Key, Geiger Key, Grassy Key, Key Largo, Vaca Key, Stock Island
<i>Cx. (Melanoconion) atratus</i> Theobald	Annette Key, Big Pine Key, Big Torch Key, Boca Chica Key, “Crawl Keys”, Cudjoe Key, Elliott Key, Geiger Key, Grassy Key, Key Largo, Key West, Lignumvitae Key, Little Knockemdown Key, Little Pine Key, Long Key, Lower Matecumbe Key, Middle Torch Key, No Name Key, Plantation Key, Ramrod Key, Saddlebunch Keys, Stock Island, Sugarloaf Key, Summerland Key, “Torch Key”, Vaca Key, Water Keys, Windley Key
<i>Cx. (Mel.) cedecei</i> Stone and Hair	Big Pine Key, Big Torch Key, Key Largo, Key West, Little Knockemdown Key, Stock Island, Sugarloaf Key
<i>Cx. (Mel.) erraticus</i> Dyar and Knab	Big Pine Key, Big Torch Key, Cudjoe Key, Cross Key, Geiger Key, Grassy Key, Key Largo, Key West, Long Key, No Name Key, Stock Island, Sugarloaf Key, Upper Matecumbe Key
<i>Cx. (Mel.) iolambdis</i> Dyar	Annette Key, Big Pine Key, Cudjoe Key, Geiger Key, Key Largo, Key West, Long Key, No Name Key, Plantation Key, Stock Island, Upper Matecumbe Key, Vaca Key, Windley Key
<i>Cx. (Mel.) mulrennani</i> Basham	Big Pine Key, Cudjoe Key, Key Largo, Long Key, Ramrod Key
<i>Cx. (Mel.) peccator</i> Dyar and Knab	Big Pine Key, Big Torch Key, Boca Chica Key, Cudjoe Key, Geiger Key, Key Largo, Key West, Little Knockemdown Key, Little Pine Key, Long Key, Middle Torch Key, No Name Key, Plantation Key, Stock Island, Sugarloaf Key, Summerland Key, Upper Matecumbe Key, Water Keys
<i>Cx. (Mel.) pilosus</i> Dyar and Knab	Big Pine Key, Cudjoe Key, Geiger Key, Key Largo, Little Knockemdown Key, Little Pine Key, Stock Island, “Torch Key’, Vaca Key
<i>Deinocerites cancer</i> Theobald	Annette Key, Bahia Honda Key, Big Coppitt Key, Big Pine Key, Big Torch Key, Boca Chica Key, Boot Key, Cross Key, Cudjoe Key, Geiger Key, Key Largo, Lignumvitae Key, Little Knockemdown Key, Little Pine Key, Long Key, Middle Torch Key, No Name Key, Plantation Key, Raccoon Key, Ramrod Key, Rodriguez Key, Stock Island, Sugarloaf Key, Summerland Key, Sunrise Cay, Vaca Key, Water Keys, Windley Key
MANSONIINI	
<i>Coquillettidia (Coquillettidia) perturbans</i> (Walker)	Annette Key, Key Largo, Little Knockemdown Key, Long Key
<i>Mansonia (Mansonia) dyari</i> Belkin, Heinemann, and Page	Big Pine Key, Grassy Key
<i>Ma. (Man.) titillans</i> (Walker)	Long Key, Vaca Key
SABETHINI	
<i>Wyeomyia (Wyeomyia) mitchellii</i> (Theobald)	Big Pine Key, Cudjoe Key
<i>Wy. (Wyo.) vanduzeei</i> Dyar and Knab	Big Pine Key, Big Torch Key, Key Largo, Little Knockemdown Key, Ramrod Key
URANOTAENIINI	
<i>Uranotaenia (Uranotaenia) lowii</i> Theobald	Annette Key, Big Pine Key, Big Torch Key, Cross Key, Cudjoe Key, Grassy Key, Key Largo, Little Knockemdown Key, Little Pine Key, Long Key, Lower Matecumbe Key, Middle Torch Key, No Name Key, Plantation Key, Rodriguez Key, Stock Island, Sugarloaf Key, Sunrise Cay, Upper Matecumbe Key, Vaca Key, Windley Key
<i>Ur. (Ura.) sapphirina</i> (Osten Sacken)	Stock Island

Early Twentieth Century

During the early years of the Twentieth Century, the 1900s to the 1930s, very little work was done on the mosquitoes of the Florida Keys. A few species were reported but there was no sustained effort to record the fauna. The first published records of mosquitoes from the Florida Keys were in Coquillett’s description of *Culex nanus* (Coquillett 1903). Coquillett described his new species based on 10 specimens, four collected in August 1901 in Key West by August Busck, and six others collected 1 to 3 April 1903 by E.A. Schwarz. *Culex nanus* is now regarded

as a synonym of *Psorophora pygmaea* (Theobald) (Dyar and Knab 1906). A year later, in 1904, Gardner (1904) reported the presence of *Anopheles albimanus* Wiedemann in Key West (as *An. argyritarsis albipes* Theobald, see Rozeboom and Gabaldón (1941) for discussion of synonymy). Dyar and Knab (1906) described *Anopheles atropos* from the “Florida Keys”; they did not specify a locality. Johnson (1913), in his treatment of the Diptera of Florida, listed eight mosquito species in the Florida Keys, viz., *Anopheles albimanus*, *An. atropos*, *Psorophora ciliata* (as *Psorophora ciliatus* [sic]), *Psorophora pygmaea*

(as *Janthinosoma pygmaea*), *Aedes aegypti* (as *Stegomyia calopus*, see Dyar 1920), *Aedes taeniorhynchus* (as *Aedes niger*), *Culex quinquefasciatus*, and *Culex bahamensis* (as *Culex corniger*). The name “*Psorophora ciliatus*” is most likely a typographic error; nowhere else has this species been given that epithet. Since its description by Fabricius, it has always been “*ciliata*”.

In 1915, Howard, Dyar, and Knab mentioned generally that *Deinocerites cancer* and *Wyeomyia mitchellii* (Theobald) (as *Wy. antoinetta* Dyar and Knab) were found in “Southern Florida”; they also reported *Cx. bahamensis* from Knights Key (as *Cx. corniger*) and *Cx. quinquefasciatus* Say from Key West. In 1917, Howard, Dyar, and Knab included records of *Ps. ciliata* from Key West collected by Busck in August of 1901; the above mentioned records of *Ps. pygmaea*, *Ae. taeniorhynchus* from Knights Key and Key West (as *Ae. niger*); *Ae. aegypti* from Key West (as *Ae. calopus*), *An. albimanus* from Key West; *An. atropos* from “Florida Keys”. Dyar (1922) included earlier records of Coquillett (1903), Johnson (1913), and Howard *et al.* (1915; 1917), and reported a new record of *Ae. sollicitans* from Ramrod Key. Two years later Mozzette (1924) reported the presence of *Ae. taeniorhynchus* on Bamboo Key. Toward the end of the 1930s, previously reported records of mosquitoes from the Florida Keys were included in a review of the distribution of *An. albimanus* (King 1937) and a handbook for identification of mosquitoes of the southeastern United States (King *et al.* 1939). At the end of the decade, Fisk (1939) reported *An. atropos* and *Cx. bahamensis* from the island of Key West. King and Bradley (1941) reviewed the distribution of *Anopheles* species in the United States, citing earlier records of *An. albimanus* and *An. atropos* in the Florida Keys.

Second World War

The outbreak of the Second World War stimulated research on mosquitoes throughout the world. King *et al.* (1942) updated their handbook of mosquitoes of the southeastern United States; in this revision they included new records of *Cx. bahamensis* from Elliott Key. A number of new records were reported from the Florida Keys during this period. Several species were described from material collected in the Florida Keys, as well. Roth and Young (1944) reported a new species record, *Cx. atratus*, from the Florida Keys. Wirth (1945) reported *Ae. taeniorhynchus* from Key Largo. In this same paper he also reported *Cx. (Melanoconion) elevator* Dyar and Knab from Key Largo. Pratt and Seabrook (1952), however, determined that these specimens actually were *Cx. (Mel.) iolambdis* Dyar. Staebler and Buren (1946) recorded a new national record, *Ae. tortilis*, from Key West. Buren (1946) also confirmed the establishment of *Ps. pygmaea* in Florida. Buren (1947) also described a new species, *Ae. keyensis*, from Key West. Thurman and coauthors (1949) later synonymized *Ae. keyensis* with *Ae. thelcter* Dyar, and reported records from Long Key, Key Largo, Key West, and Vaca Key.

The publication of an annotated list of Florida Keys mosquitoes by Pritchard *et al.* (1947) added many new records to the fauna of the Florida Keys. In total, 28 species were recorded, including *Ae. euplocamus* Dyar and Knab and *Ps. confinnis* (Lynch Arribalzaga). Arnell (1976), however, stated that *Ae. euplocamus* was known only

from Mexico, Costa Rica, El Salvador, Panama, Colombia, and Venezuela, and that the specimens from Vaca Key misidentified as *Ae. euplocamus* by Pritchard *et al.* (1947) were actually *Ae. scapularis* (Rondani). Furthermore, Bickley (1984) reported that *Ps. confinnis* did not occur in the southeastern United States, and that the proper identity of this *Psorophora* species was *Ps. columbiae* Dyar and Knab.

Anopheles quadrimaculatus Say had not been reported from the Florida Keys during any of the prior mosquito surveys, although it had been collected from the near adjacent mainland (Thurman 1948). In 1948, Basham and Haeger (1948) reported the collection of small numbers of *An. quadrimaculatus* from Big Pine Key, Key Largo, and Plantation Key. Reinert *et al.* (1997) eventually determined that the nominal species *An. quadrimaculatus* was a complex of five morphologically similar species. They did not assign the records of Basham and Haeger to any of the five species described in their paper.

Pritchard *et al.* (1947) reported collecting an undescribed *Culex* species during their survey of the mosquitoes of the Florida Keys. Basham (1948) described a new species of *Culex* (*Melanoconion*), *Cx. (Mel.) mulrennani*, from material collected on Big Pine, Cudjoe, and Ramrod Keys; this was the undescribed species reported previously by Pritchard *et al.* (1947).

Post World War Two

The decades of the 1950s and 1960s saw very little work on the mosquitoes of the Florida Keys. Branch *et al.* (1958) collected *Mansonia titillans* (Walker) from Vaca Key, and *An. albimanus* from several islands. These authors also reported *Ae. (Aedemorphus) vexans* (Meigen) and *Ma. indubitans* (Dyar and Shannon) from Monroe County. No island was specified, and these records most likely refer to the mainland portion of Monroe County. In their description of *Ma. dyari*, Belkin *et al.* (1970) stated that all records of *Ma. indubitans* from Florida and elsewhere in the southeastern United States were likely *Ma. dyari*. Moreover, Branch *et al.* (1958) reported *Cx. opisthopus* from the mainland of Monroe County. Stone and Hair (1968) described *Cx. cedecei* from Florida and stated that all records of *Cx. opisthopus* in the United States correctly were *Cx. cedecei*. In 1960, King *et al.* (1960) again updated their manual of mosquitoes of the southeastern United States.

Late Twentieth Century and Twenty-First Century

Beginning in the late 1990s and continuing until the present, the Florida Keys Mosquito Control District has surveyed the Florida Keys and has reported numerous new distribution records within the island chain. Three species new to the fauna of the United States were recognized based entirely or in part on specimens collected in the Florida Keys. Other species that had not been collected for years were recorded once again from the Florida Keys. Hribar (1999) collected *An. albimanus* from Long Key and No Name Key. Hribar (2001) made the first report of *Cx. peccator* Dyar and Knab from Monroe County, on Big Pine Key. In that same paper *Ps. johnstonii* was reported from Summerland Key for the first time. Hribar and Vlach (2001) reported several mosquito species from state

parks in the Florida Keys, including records from Bahia Honda Key. Hribar *et al.* (2001) presented larval collection records from several islands in the area of Key West. Hribar (2002) analyzed collection records from a number of islands within the Florida Keys, and reported *Culiseta melanura* Coquillett from No Name Key. Darsie *et al.* (2002) reported a new addition to the fauna of the United States, *An. grabhamii* Theobald, from Big Pine Key. Later, Hribar (2005) reported *An. grabhamii* from No Name Key. Darsie (2003) reported the first collections of *Ae. condolezens* Dyar and Knab from Annette Key, Big Pine Key, and Howe Key. Later Hribar *et al.* (2005) reported *Ae. condolezens* from 22 different islands within the Florida Keys. Darsie and Shroyer (2004) reported *Cx. declarator* Dyar and Knab from Big Pine Key, Key Largo, and Long Key.

ACKNOWLEDGMENTS: The authors thank the numerous inspectors and technicians employed by the Florida Keys Mosquito Control District who throughout the years have collected specimens. We also thank Kristen Bird for preparing the figure. Dr. R.F. Darsie, Jr. identified or verified some of the specimens reported herein.

LITERATURE CITED

- Arnell, J.H. 1976. Mosquito studies (Diptera, Culicidae). XXXIII. A revision of the *scapularis* group of *Aedes* (*Ochlerotatus*). *Contributions of the American Entomological Institute* 13(3): 1-144.
- Basham, E.H. 1948. *Culex* (*Melanoconion*) *mulrennani*, a new species from Florida. *Annals of the Entomological Society of America* 41(1): 1-7.
- Basham, E.H. and J.S. Haeger. 1948. Records of *Anopheles quadrimaculatus* Say for the Florida Keys. *Mosquito News* 8(1): 72.
- Belkin, J.N., S.J. Heinemann and W.A. Page. 1970. The Culicidae of Jamaica (Mosquito Studies, XXI). *Contributions of the American Entomological Institute* 6(1): 1-458.
- Bickley, W.E. 1984. Notes on the *Psorophora confinnis* complex. *Mosquito Systematics* 16(2): 162-167.
- Branch, N., L. Logan, E.C. Beck and J.A. Mulrennan. 1958. New distributional records for Florida mosquitoes. *Florida Entomologist* 41(4): 155-163.
- Buren, W.F. 1946. *Psorophora pygmaea* (Theobald), an exotic mosquito now established in Florida. *Mosquito News* 6(4): 185.
- Buren, W.F. 1947. A new *Aedes* from the Florida Keys. *Proceedings of the Entomological Society of Washington* 61(8): 228-229.
- Coquillett, D.W. 1903. Four new species of *Culex*. *Canadian Entomologist* 35(9): 255-257.
- Corbett, D.R., J. Chanton, W. Burnett, K. Dillon, C. Rutkowski and J.W. Fourqurean. 1999. Patterns of groundwater discharge into Florida Bay. *Limnology and Oceanography* 44(4): 1045-1055.
- Darsie, R.F., Jr. 2003. First report of *Ochlerotatus condolezens* (Dyar and Knab) (Diptera: Culicidae) in the United States. *Proceedings of the Entomological Society of Washington* 105(4): 1067-1068.
- Darsie, R.F., Jr. and C.D. Morris. 2000. *Keys to the adult females and fourth instar larvae of the mosquitoes of Florida*. Technical Bulletin of the Florida Mosquito Control Association Volume 1 (revised). 159 p.
- Darsie, R.F., Jr. and D.A. Shroyer. 2004. *Culex* (*Culex*) *declarator*, a mosquito species new to Florida. *Journal of the American Mosquito Control Association* 20(3): 224-227.
- Darsie, R.F., Jr., J.J. Vlach and E.M. Fussell. 2002. New addition to the mosquito fauna of United States, *Anopheles grabhamii* (Diptera: Culicidae). *Journal of Medical Entomology* 39(3): 430-431.
- DeMay, D.J. and L.J. Hribar. 2005. Species composition, seasonal distribution, and relative abundance of mosquitoes (Diptera: Culicidae) on Lignumvitae Key in the Florida Keys, USA. *Trends in Entomology* 4: 71-74.
- DeMay, D.J. and L.J. Hribar. 2008. Mosquito fauna of Key Largo, Florida. *Journal of the American Mosquito Control Association* 24(4): 471-477.
- DeMay, D.J. and L.J. Hribar. 2009. Mosquito (Diptera: Culicidae) collection records from Boot Key, Florida. *Florida Scientist* 72(3): 240-241.
- Dyar, H.G. 1920. The earliest name of the yellow fever mosquito (Diptera, Culicidae). *Insector Inscitiae Menstruus* 8(10-12): 204.
- Dyar, H.G. 1922. The mosquitoes of the United States. *Proceedings of the United States National Museum* 62: 1-119.
- Dyar, H.G. and F. Knab. 1906. Notes on some American mosquitoes with descriptions of new species. *Proceedings of the Biological Society of Washington* 19(6): 159-172.
- Fisk, F.W. 1939. New mosquito records from Key West. *Journal of Economic Entomology* 32(3): 469.
- Gardner, C.H. 1904. *Anopheles* mosquitoes found at Key West, Florida. *Public Health Reports* 195(34): 1651.
- Hoffmeister, J.E. and H.G. Multer. 1968. Geology and origin of the Florida Keys. *GSA Bulletin* 9(11): 1487-1502.
- Howard, L.O., H.G. Dyar and F. Knab. 1915. The Mosquitoes of North and Central America and the West Indies. Systematic Description, part I. *Carnegie Institute of Washington Publication* 159(3): 1-523.
- Howard, L.O., H.G. Dyar and F. Knab. 1917. The Mosquitoes of North and Central America and the West Indies. Systematic Description, part II. *Carnegie Institute of Washington Publication* 159(4): 525-1064.
- Hribar, L.J. 1999. Continued presence of *Anopheles albimanus* (Diptera: Culicidae) in Monroe County, Florida. *Entomological News* 110(5): 317-319.
- Hribar, L.J. 2001. Uncommonly collected mosquitoes from the Florida Keys. *Entomological News* 112(2): 123.
- Hribar, L.J. 2002. Mosquito (Diptera: Culicidae) collections in the Florida Keys, Monroe County, Florida, USA. *Studia Dipterologica* 9(2): 679-691.
- Hribar, L.J. 2005. New locality record for *Anopheles grabhamii* (Diptera: Culicidae) from the Florida Keys. *Florida Scientist* 68(2): 8-10.
- Hribar, L.J. 2007. New and old mosquito records for extreme southern Florida. *Insecta Mundi* 5: 1-3.
- Hribar, L.J. and J.J. Vlach. 2001. Mosquito (Diptera: Culicidae) and biting midge (Diptera: Ceratopogonidae) collections in Florida Keys state parks. *Florida Scientist* 64(3): 219-223.
- Hribar, L.J., J. M. Smith, J.J. Vlach and T.N. Verna. 2001. Survey of container-breeding mosquitoes from the Florida Keys, Monroe County, Florida. *Journal of the American Mosquito Control Association* 17(4): 245-248.
- Hribar, L.J., D.J. DeMay, M.J. Hemmen and A.L. Leal. 2005. Observations on the distribution and seasonality of *Ochlerotatus condolezens* (Dyar & Knab) in the Florida Keys, USA (Diptera: Culicidae). *Studia Dipterologica* 12(1): 361-362.
- Johnson, C.W. 1913. Insects of Florida. III. Diptera. *Bulletin of the American Museum of Natural History* 32: 37-90.
- King, W.V. 1937. On the distribution of *Anopheles albimanus* and its occurrence in the United States. *Southern Medical Journal* 30(9): 943-946.
- King, W.V. and G.H. Bradley. 1941. Distribution of the Nearctic species of *Anopheles*. *American Association for the Advancement of Science Publication* 15: 71-78.
- King, W.V., G.H. Bradley, and T. E. McNeel. 1939. The mosquitoes of the southeastern states. *USDA Miscellaneous Publication* 36. 1-87.
- King, W.V., G.H. Bradley, and T. E. McNeel. 1942. The mosquitoes of the southeastern states, revised. *USDA Miscellaneous Publication* 336. 1-95.
- King, W.V., G.H. Bradley, C.N. Smith, and W.C. McDuffie. 1960. *A handbook of the mosquitoes of the southeastern United States*. USDA Agriculture Handbook 173. 188 p.
- Leal, A.L. and L.J. Hribar. 2010. Mosquito fauna of wilderness islands within the National Key Deer Refuge and the Great White Heron National Wildlife Refuge, Monroe County, Florida. *Journal of the American Mosquito Control Association* 26(2): 141-147.
- Pratt, H.D. and E.L. Seabrook. 1952. The occurrence of *Culex iolambdis* Dyar in Florida and Puerto Rico, with a description of the larva. *Proceedings of the Entomological Society of Washington* 54(1): 27-32.

- Pritchard, A.E., E.L. Seabrook and J.A. Mulrennan. 1947. The mosquitoes of the Florida Keys. *Florida Entomologist* 30(1-2): 8-15.
- Reinert, J.F. 1975. Mosquito generic and subgeneric abbreviations (Diptera: Culicidae). *Mosquito Systematics* 7(2): 105-110.
- Reinert, J.F., P.E. Kaiser and J.A. Seawright. 1997. Analysis of the *Anopheles* (*Anopheles*) *quadrimaculatus* complex of sibling species (Diptera: Culicidae) using morphological, cytological, molecular, genetic, biochemical, and ecological techniques in an ecological approach. *Journal of the American Mosquito Control Association* 13(Supplement): 1-102.
- Ross, M.S., J.J. O'Brien and L.J. Flynn. 1992. Ecological site classification of Florida Keys terrestrial habitats. *Biotropica* 24(4): 488-502.
- Roth, L.M. and F.N. Young. 1944. *Culex* (*Melanoconion*) *atratus* Theobald in Florida: a new North American continental record, with notes on the other *Melanoconions* of the southeastern United States. *Annals of the Entomological Society of America* 37(1): 84-88.
- Rozeboom, L.E. and A. Gabaldón. 1941. A summary of the "*tarsimaculatus*" complex of *Anopheles* (Diptera; Culicidae). *American Journal of Hygiene* 33(3): 88-100.
- Snyder, J.R., A. Herndon and W.B. Robertson, Jr. 1990. South Florida rockland; p. 230-277 In R.L. Myers and J.J. Ewel (ed.). *Ecosystems of Florida*. University of Central Florida Press.
- Staebler, A.E. and W.F. Buren. 1946. *Aedes tortilis* (Theobald), a mosquito new to the United States. *Entomological News* 57(6): 157.
- Stern, W.L. and G.K. Brizicky. 1957. The woods and flora of the Florida Keys. Introduction. *Tropical Woods* 107: 36-65.
- Stone, A. and J.A. Hair. 1968. A new *Culex* (*Melanoconion*) form Florida (Diptera, Culicidae). *Mosquito News* 28(1): 39-41.
- Thurman, D.C., Jr. 1948. A far south record of *Anopheles quadrimaculatus* Say. *Mosquito News* 8(1): 19.
- Thurman, E.B., J.S. Haeger and J.A. Mulrennan. 1949. The occurrence of *Aedes* (*Ochlerotatus*) *thelcter* Dyar in the Florida Keys. *Mosquito News* 9(4): 171-172.
- Wirth, W.W. 1945. The occurrence of *Culex* (*Melanoconion*) *elevator* Dyar and Knab in Florida, with keys to the *Melanoconions* of the United States. *Proceedings of the Entomological Society of Washington* 47(7): 199-210.

RECEIVED: September 2010

LAST REVISED: April 2011

ACCEPTED: June 2011

PUBLISHED ONLINE: July 2011

EDITORIAL RESPONSIBILITY: Cristiano Lopes-Andrade

Mosquitoes (Insecta: Diptera: Culicidae) of the Florida Keys, Florida, United States of America

Lawrence J. Hribar^{1*}, Andrea L. Leal², David J. DeMay¹ and Adriane N. Tambasco³

1 Florida Keys Mosquito Control District, 503 107th Street, Marathon, FL 33050, USA.
2 Florida Keys Mosquito Control District, 5224 College Road, Key West, FL 33040, USA.
3 Florida Keys Mosquito Control District, 100701 Overseas Highway, Key Largo, FL 33037, USA.
* Corresponding author. Email: lhribar@keysmosquito.org

ERRATUM

PAGE 459: Heading of **TABLE 1** should be: Culicidae known to occur in the Florida Keys. We regret these errors.

PAGE 459: Within **TABLE 1**, *Aedes* (*Ochlereotatus*) *atlanticus*, subgenus should be "*Ochlerotatus*". August 2011.